

Minutes of the Beam-beam Simulation Meeting 10/28/2005

Fri Oct. 28, 2005, Beam-beam Simulation meeting 14:30 911B SCR

Attendance: JBBW, WM, AL, YL, NM, TJS, CM, DT, VL, ST

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JBBW:

About LIFETRAC

1. Originally written by Dmitri Shatilov, BINP SB RAS, Novosibirsk, Russia;
2. weak-strong Macroparticle tracking for e-/e+/p/pbar;
3. Full 6D, gaussian or any input distribution from file;
4. Fortran90, about 10k lines, runs on Linux;
5. Intel compiler 7.1 (current free version from Intel is 9.0);
6. Speed: 10^{10} particles-turns/day on 32-node P4 cluster

Comparison of Beam-beam code uses:

LIFETRAC/BBSIM/PLIBB: Lifetime calculation

BEAMBEAM3D: Lifetime, coherent modes

SIXTRACK/MAD/TEVLAT: Dynamic aperture

BBDEMO2C/BEAMX/COMBI: Coherent modes

WSDIFF: Diffusion

SPINK: Spin polarization effects (AL: Other beam is just lens distribution not fully beam-beam strictly speaking)

About Sixtrack:

1. Single particle code optimized to carry 2 particles through machine for a large number of turns.
2. Symplectic treatment of full 6D motion, including synchrotron motion;
3. Calculate long-term dynamic aperture by detecting chaotic motion;
4. Calculate 1st order resonances and correction schemes (useful for 2/3?)
5. Calculate one-turn map using differential algebra techniques;
6. Ramp energy with consideration of relativistic changes in velocity;
7. Calculate average, max, min emittance and invariants of coupled motion;
8. Beam-beam is weak-strong, fixed nonlinear kicks

Advanced features in LIFETRAC:

1. 2D coupled optics, weak-strong;
2. 3D beam-beam kick computed using interpolated formulae, longitudinal;
3. Longitudinally sliced strong bunch Bunch;
(NM: Is this analytical kick? JBBW: Yes.)
4. Strong beam doesn't see weak beam, completely weak-strong;

5. Strong bunch can be non-Gaussian (superposition of up to 3 Gaussian distributions with different emittances);
(VL: This is great for electron cooling since beams will be non- Gaussian.)
6. Chromatic modulation of beta functions;
7. Longitudinally sliced strong bunch for transformation through main IPs
(VL: Implies that it includes synchrotron resonance effects)
8. Beam tail treatment: can weight macroparticles in tails less than particles in tail, and use more macroparticles in the tail to evaluate tail and halo evolution.
9. Weak beam can have up to 10k particles.
10. Parallel computation.

(AL: 10k particles is not much. Thousands are nothing on this scale. This is only 100 particles per dimension in 3D.

VL: Why so few particles? Because we need millions of turns. AL: million particles for a million turns is really too much, and too long (100 days!). Goal generally is millions of particles for tens of thousands of turns.)

VL: Do we have a specific problem for LIFETRAC to crack?

JBBW:

Scope of LIFETRAC package (diagram)

Eight output files go to Lftrgui (post-processing) and Lgui (plotting)

Plots

normalized beam intensity,
loss rate, emittances,
bunch length,
luminosity over time.

Installed on godzilla and runs properly with parallel processing Graphics and post-processing programs are also installed on Godzilla. Source code is not available. (NM: Why not?) Test runs with basic RHIC parameters have been performed, currently setting up test runs for RHIC and eRHIC

Discutions:

VL: Tevatron people are very happy with this code -- good results against their beam experiments, halo development, luminosity evolution. In principle this code is already baselined against a machine of similar size (the Tevatron), though in the weak-strong case instead of strong-strong.

VL: Is it two machines or one machine?

CM/TJS: Weak-strong, so the strong distribution doesn't evolve and it doesn't really matter. Strong beam is fixed.

AL: Need to have the code to integrate other codes into UAL framework and environment, if this is the direction that we want to go.

VL: Why should we wait to incorporate this into a structure? It's just a tool, don't need to wait -- these things can happen in parallel.

VL: Can take output distribution and feed back in to another iteration of code to simulate strong-strong, at least to look at onset of instabilities.

WM want to investigate how we cog beams into collision, longitudinal vs transverse.

JBBW: Don't think that the distance/angle of two beams are variables, could do simulations in steps or ask them to put in a functional dependence.

VL: Maybe can simulate this in other codes, since the beam-beam blowup happens quite quickly. Think LIFETRAC is designed to look at long-term beam-beam effects, not short-term effects.

VL suggests focusing on long-term beam-beam effects in pp to baseline our threshold of beam-beam stability in RHIC with 2 or 3 collisions. This is relatively straightforward to do. Why not model the p-p run and see if we get relatively similar behavior? For ions need burn-off rates and IBS added in.

NM wants to benchmark this code against UAL. In some sense they are orthogonal, couldn't baseline beam-beam in UAL against RHIC yet. Also provides hooks for extensions, so would like to simulate the same problem set with both to benchmark. UAL has similar beam-beam: weak-strong with multi-Gaussian strong beam, weak beam is any number of particles. Tested against Christoph's program, but not any other beam-beam simulation.

VL: We should stay focused on RHIC as our goal, use lattice that we used last year at 100 GeV to simulate and see where we break down in intensity. What is luminosity limitation with current beam pattern and two collision points?

DT: There are predictions from WF/VP based on analytical formulae.

AL: Really important to coordinate what we do, wanted a simulation group or theory group, or at least regular AP group meetings. Different people are working on the same types of questions, but organization and sharing of effort efficiently is worrisome. Worried that we're contributing to the proliferation of codes. Frustrated about people not knowing what Alfredo is doing to develop his codes.

VL: Why not use code for AGS and RHIC?

AL: Working on it in a limited way, also want to work with others.

VL: Suggests reporting on modeling developments in Dejan's RHIC meeting.

AL: Mostly worried about lack of manpower to do too many different things, but VL counters that NM/JBBW have interest and time, and feels that JBBW's time spend on beam-beam simulations would be a good investment.